

TITLE

TRACTOR WITH MONITORING SYSTEM

claim 1
The present invention relates to a tractor with a monitoring system and means for locating the tractor.

It is known to display sensed parameters on an electronic tractor monitoring system. It is also known to provide a location system, eg a GPS satellite location system, in a combine harvester and to combine information from such a system with, for example, a continuous signal representative of the rate of flow of grain entering the harvester, thereby to produce a "yield map" showing grain yield as a map over an area where the combine harvester has travelled.

claim 2
The object of the present invention is to provide a tractor with an improved monitoring system.

In accordance with the present invention a tractor is provided having the features of Claim 1 hereto, with optional features listed in Claims 2 to 7. A method in accordance with the invention is set out in Claim 8 hereto, with preferable features set out in Claims 9 and 10 hereto.

claim 3
Further features and details of the present invention will be apparent from the following specific description given by way of example only with reference to the accompanying drawings in which:

Figure 1 is a schematic side sectional view of a tractor in accordance with the invention,
and

Figure 2 is an example map produced in accordance with the invention.

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Referring firstly to Figure 1, a tractor in accordance with the invention comprises the standard elements of an engine E, gearbox G/B, PTO output shaft P, and three point linkage L.

Situated in the tractor cab is an electronic monitoring system analysis/display unit 1 into which run lines from a number of electronic sensors on the tractor.

A fuel tank 2 is housed at the rear of the tractor and a fuel line 3 passes from the tank to the engine E via a fuel flow sensor 4. An electronic output from the fuel flow sensor 4 is connected via line 5 to the display unit 1.

A further sensor 6 for detecting engine speed, is of the magnetic inductance type and is mounted adjacent a gear 7 which drives the engine oil pump. The electronic output of the sensor 6 is connected via a line 9 to the display unit 1.

A radar speed sensor 10 is mounted underneath the tractor for detecting actual speed over the ground. The sensor 10 is connected via a line 11 to the display unit 1.

A further magnetic inductance sensor 12 is associated with the crown wheel 13 on the rear axle of the tractor for detecting "theoretical" forward speed (ie forward speed with no wheel slip). The electronic output of the inductance sensor 12 is connected via a line 14 to the display unit 1.

A further magnetic inductance sensor 15 is associated with the power take off gearbox 16 and detects the PTO speed. The electronic output of the sensor 15 is connected via a line 17 to the display unit 1.

The three point linkage L has both draft force and position sensors associated with the top link joint, the sensors being commonly shown in Figure 1 by the numeral 18. The force sensor is of known type, taking the form of a joint pin incorporating strain gauges. The electronic output from the force sensor is connected via a signal line 19 to the display unit 1. The position of the linkage, that is to say its height, is measured by a rotary potentiometer

associated with the top link joint. The potentiometer is connected via a line 20 to the display unit 1.

Situated in the tractor cab is an electronic linkage control unit 21 of known type, which includes a linkage lift/lower control 22. The electronic linkage control unit is connected via a line 23 to the display unit 1.

The tractor is fitted with a GPS satellite navigation system 24 which is connected via signal line or lines 25 to the display unit 1.

Finally, a socket 26 is provided for receiving an input signal from an implement connected to the tractor, and this is connected via a line 27 to the display unit 1.

The display unit 1 includes a touch sensitive screen 28 via which a number of functions connected with monitoring/displaying tractor parameters may be selected and controlled. The unit 1 also allows the various parameters as sensed on the tractor, as well as information derived therefrom, to be displayed on the screen 28, or alternatively output on to a data carrier inserted into a slot 29, or alternatively output in printed form on a paper tape output from slot 30.

The display unit 1 is essentially also a data processing unit, as will be appreciated from what has been said above. The unit includes an integral clock, a microprocessor and electronic memory. Software to enable the functions described above to be performed, is stored and implemented by the unit 1. The unit 1 is programmed to accept the input of certain parameters either manually via the touch screen or via a data carrier, such as a magnetic disk or PCMCIA card inserted in to the slot 29. The unit 1 is also programmed to receive information from the GPS navigation system 24 and combine this with any of the parameters sensed by the various sensors around the tractor together with any relevant data input manually or via a data carrier. In this way, the unit produces maps of tractor speed information which may be combined with manually input information.

At its simplest level, the system may be used to generate, for example, a map of fuel used per hectare when performing an operation with a soil penetrating implement. To generate such a map, the unit 1 would employ information from the GPS unit 24, from the fuel flow sensor 4, from the tractor speed sensor 10 and from a manual input representative of the width of the implement being used, and thus the width of the strip of field processed on any given run of the tractor. The unit 1 would also use the input from the electronic linkage control 21, which includes an indication of whether the implement is in a raised or lowered condition and therefore out of work or in work. Lastly, the unit 1 would use information from its integral clock.

A realistic map of fuel used per hectare may then be generated by continuously sensing the fuel flow data from the sensor 4 and continuously calculating the rate at which area is being covered (derived from speed and implement width), and sampling these parameters repeatedly at known positions of the tractor (from the GPS). At each sampling point, a value for fuel used since the last sample is divided by hectares covered since the last sample and this fuel/hectare value correlated to tractor position. At the end of each run, the linkage will of course be raised to bring the implement out of work and this fact will be recognised by the unit 1 from the signal on line 23 from the electronic linkage control 21. The amount of fuel used from the time the implement is lifted out of work until the time it is returned into work at the start of the next run can be retrospectively added to the series of fuel/hectare values for the previous run, being apportioned equally over all the readings. Alternatively, the value for fuel used can be stored and then apportioned equally over the readings for the next run. Either way, the fuel used per hectare figure for a narrow portion of field with very short runs will reflect the fact that the tractor spends a relatively large percentage of its time turning on headlands.

In a simple modification of the above process, the fuel used per hectare figure can be amended to a fuel cost per hectare figure by the simple incorporation of a manually input unit fuel cost figure.

It will be appreciated that the operation described above involves automatic sensing of lifting and lowering of the tractor linkage at each end of a run (simply by noting the position of the

lift/lower switch 22). Alternatively, in an operation where the linkage is not lifted and lowered at the end/start of each run (eg spreading fertiliser), a further manual input can be provided in the form of an icon on the touch screen which is touched at the end and the start of each run. Alternatively, this information could be input directly from the implement via the socket 26 and line 27. There could also be some form of connection between the unit 1 and a cab mounted implement control unit to achieve the same result.

The above described operation is a novel and relatively simple way of providing an indication of the cost of performing a process on a field, showing how that cost is distributed across the field. A more useful way of doing this is to combine all or at least most of the sensed tractor parameters described above with data input manually or via a data carrier as follows:

- 1 cost of tractor driver per hour;
- 2 depreciation of tractor per hour;
- 3 maintenance cost of tractor per hour;
- 4 a parameter representative of tractor tyre cost per hour;
- 5 a parameter representative of soil type.

The cost of a driver's wages, depreciation and maintenance need no explanation; their effect on the cost of the tractor operation is self-explanatory. Actual tractor tyre wear is influenced by a number of factors, so a basic tyre cost parameter is used representing purchase cost depreciated over an average tyre lifetime. This is then modified by the unit 1 according to the soil type parameter, since certain types of soil will wear a tyre quicker than others. Other factors used to calculate actual tyre wear, and therefore cost, are wheel slip, which is directly calculated from the actual speed sensor 10 and theoretical speed sensor 12, draft force from the draft force sensor 18 assuming a soil penetrating implement is attached, and forward speed from the sensor 10.

A possibility with this system is the generation of cumulative treatment cost maps. A previously generated cost map for a given treatment, eg ploughing a field, may be inserted into the unit 1, and then information relating to the cost of a second process added as the second process is performed. If this is done for every treatment applied to the field, a reasonably true

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